

Report for 2002AZ9G: Agricultural Chemicals as a Major Non-Point Source of Arsenic: Microbial Transformation of Organic Arsenicals

There are no reported publications resulting from this project.

Report Follows:

First Year Progress Report

Agricultural Chemicals as a Major Non-Point Source of Arsenic: Microbial Transformation of Organic Arsenicals

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Large quantities of arsenic (As) can enter into the environment as organo-arsenic compounds through agricultural activity. Methylarsonic acid (MMA^{V}) and dimethylarsinic acid (DMA^{V}) are utilized as herbicides in cotton and roxarsone (3-nitro-4-hydroxyphenylarsonic acid) is used as a feed additive in poultry. The goal of this project is to evaluate the biodegradability and identify major metabolites accumulating from the bioconversion of organoarsenicals.

MMA^{V} (0.7 mM) and DMA^{V} (0.5 mM) were incubated in anaerobic microcosm established in serum bottles. Parent compounds and metabolites were monitored with ion chromatography/inductively coupled plasma/ mass spectrometry (IC/ICP/MS). Three redox conditions were tested, either denitrifying (with 32 mM NO_3^-), sulfate reducing (with 21 mM SO_4^{2-}) or methanogenic (no alternative electron acceptor added). Controls with sterile medium and autoclaved sludge were run in parallel to monitor abiotic losses. DMA^{V} was readily degraded under methanogenic and sulfate reducing conditions, the parent compounds were completely eliminated within 14 days. MMA^{V} was the only intermediate detected during DMA^{V} degradation, accounting for approximately 10% of the DMA^{V} added. MMA^{V} was also degraded under methanogenic and sulfate reducing conditions. 8 weeks were required to completely eliminate the parent compound with sulfate as electron acceptor; whereas in the same time period 60% of the parent compound was eliminated under methanogenic conditions. Methylarsonous acid (MMA^{III}) was detected as an intermediate, accounting for maximally 12 and 7% of added MMA^{V} under sulfate reducing and methanogenic conditions, respectively. Additionally traces of DMA^{V} and arsenate were observed. There was no significant removal of either DMA^{V} or MMA^{V} in controls nor under denitrifying conditions. Determination of total arsenicals in the gas and liquid phases demonstrate that the large hole in the arsenic balance was not due to volatile arsenicals nor due to unidentified metabolites in solution. Presently, efforts are underway to characterize arsenicals that are sorbed onto or precipitated in the sludge. Liquid samples from these experiments did not contain any toxicity according to the AMES test.

Recently experiments have been initiated to study the anaerobic bioconversion of roxarsone. Roxarsone concentrations are being monitored by an high performance liquid chromatography coupled to a diode array detector (HPLC-DAD). Roxarsone (500 μM) was incubated with anaerobic sludge under methanogenic, sulfate reducing and denitrifying conditions as a sole source of carbon and energy. Additionally in one

treatment, lactate was added as an electron donor under methanogenic conditions to stimulate the reductive biotransformation of roxarsone. The parent compound was rapidly eliminated (100% in 8 days) under the condition with lactate added and also under sulfate reducing conditions. Presently, possible metabolites from the biotransformation are being analyzed.

The results taken as a whole indicate that simple organoarsenicals are susceptible to anaerobic biotransformations.

The future research plans are to examine the aerobic and anaerobic degradation of the simple methylarsenicals in impacted sediments collected from a cotton-growing region in Arkansas. Additionally, the toxicity of biotransformation products from roxarsone will be examined.